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Notes on Limnanthemum lacunosum, Griseb.

By Joseph Schrenk.

(Plate xlviii.)

In No. 3, Vol. x., of the Bulletin (March, 1883), Miss E. G. Knight reported the discovery of some submersed leaves in two specimens of *Limnanthemum lacunosum*, Griseb., collected in Nova Scotia. These leaves were "3 by 2.5 in., of a delicate texture, diaphanous, and of a light green color with a tinge of red," and had "a broader sinus than the floating leaves." In examining some specimens of our *Limnanthemum* that I had taken from Squam Lake, N. H., in 1881 and 1882 (in the month of August), I found that the submersed leaves of my plants were quite different from those described by Miss Knight. In 1883 and 1884 I gathered some more specimens from Squam Lake, and also some from Rockland Lake, N. Y., and from Bantam Lake, Conn., and found the submersed leaves of all the plants from these localities to agree in size and form with those taken from Squam Lake in previous years.

The blades of these leaves are only from 5 to 10$^{mm.}$ wide and about 10$^{mm.}$ long, and of various shapes, oval, obovate, broadly ovate, sometimes with truncate base, but always *without* any sinus. They are of a bright green color, without the reddish tinge peculiar to the floating leaves. The petioles are flat and from 2.5$^{cm.}$ to 9$^{cm.}$ long.

After having examined this interesting plant and its descriptions by the various authors, I venture to offer the following remarks as a contribution to the better understanding of its morphology and histology. What I especially propose to show is that the inflorescence is not inserted on the *petiole*, as stated below.*

* The latest published description of our *Limnanthemum* that I could find, is contained in the last edition (1883) of A. W. Chapman's Flora of the Southern United States, and reads thus: "*Limnanthemum*, Gmelin.. Perennial aquatic herbs with floating, circular or cordate, spongy leaves, and white peduncled flowers clustered near the summit of the long petiole." In Wood's Classbook of Botany we find the following: "Petioles long, bearing the flowers in an umbellate cyme below the roundish leaf." Gray's Manual says: "Perennial aquatics, with rounded floating leaves on very long petioles, which, in most species, bear near their summit the umbel of (polygamous) flowers . . . sometimes shooting forth new leaves from the same place, and so spreading by a sort of proliferous stolons." In Gray's Synopt. Flora of N. A. we find the following passages: "*Limnanthemum*, Gmelin . . . the flowers in our species as if umbellate-fascicled on the petiole. . . . *L. lacunosum*, Griseb. Petioles and stolons filiform, much elongated: . . . umbel of flowers borne near to the base of the leaf. . . ." De Candolle, Prodr. ix., 139, Sect. ii., Nymphæanthe, Griseb.: "Cymæ petiolis insertæ." Cf. also Thos. Meehan, The Native Flowers and Ferns of the U. S., i., 93.

Limnanthemum lacunosum has a slender, ascending or horizontal rootstock provided with fleshy, fibrous roots, (Fig. 4). At the growing end of the rhizoma we first notice, above the sandy bottom of the lake or pond, a few of the submersed leaves described above *(sl)*. Their petioles are inserted by means of sheathing bases (Fig. 5, *sl*). Next, in centripetal order, we find growing on the rootstock some very long filiform petioles of uniform thickness and appearance (Fig. 4, *pt*), likewise provided with sheathing bases (Fig. 5, *pt*), and bearing the roundish floating blades with a deep acute-angled sinus. None of these undoubted petioles shows any sign of an inflorescence.

After removing the sheathing petiole-bases, we see some membranaceous scales about $10^{mm.}$ long, which taper from a broad clasping base to a sharp point (Figs. 4 and 5, *sc*). Occasionally these scales are more elongated and have green tips or even rudimentary blades; they are, in fact, much reduced leaves.

From the axils of the scales grow those organs which are described by authors as filiform *petioles* bearing near their summit the umbel of flowers, etc. (Fig. 4, *st*). As we shall presently see, they bear lateral organs; therefore, I do not hesitate to consider them as caulomes, and will henceforth call them *stems*. They are, indeed, very much like the filiform petioles metioned above, but from those they are readily distinguished by their position in the axils of the scales, by their somewhat flattened, but never clasping base (Fig. 5, *st*), and, above all, by their internal structure, to be discussed hereafter.

A short distance from the surface of the water *(sf)*, each stem bears a well developed node, from which one full-grown floating leaf is produced. The blade of this leaf is exactly like those of the leaves with filiform petioles, but its petiole is only from 1 to $5^{cm.}$ long (in one exceptional case as long as $24^{cm.}$), rather thicker than the stem, and has, at its base, a membranaceous sheath from which the clustered inflorescence and, closely above the same, the apex of the main axis are growing. This apex, however, rarely continues its growth vigorously during the same season; but we can often observe very small rudimentary leaves starting at this point, during and after the flowering season (Fig. 4).*

The apex of the stem is usually subtended by a cluster of spur-shaped, thick and fleshy rootlets (not tubers, as they are called by some authors), (Fig. 4, *sp*, and Fig. 7.) There can be no doubt that these rootlets sink to the bottom at the end of the growing season carrying with them the apex of the stem, which, in the next spring, gives rise to a new plant. I have frequently found these rootlets attached to the rootstock of young as well as older plants, indicating, in the latter case, by their withered and shrunken condition, the function which they had performed (Fig. 6).

We see from what I have said above that in *L. lacunosum* we meet with four distinct kinds of leaf-organs: 1st, the submersed

*According to A. Gray (Manual) the long petioles sometimes shoot forth new leaves from near the spur-like roots, thus spreading by a sort of proliferous stolons.

leaves, 2d, the floating leaves with filiform petioles, 3d, the scales on the rootstock, and 4th, the floating leaves with short petioles.

But in order to obtain entire satisfaction as to the difference between the filiform petioles and stems we must examine the internal structure of the same. The fibro-vascular centre of the *stem* (Fig. 2) is distinctly divided by a zone of parenchymatic ground-tissue into two bundles, each of which contains both vascular (*v*) and sieve tissue (*sv*), the latter situated toward the endodermis (*en*). In the fibro-vascular bundle of the filiform *petiole* (Fig. 3) there is but one set of xylem (*v*) and phloem (*sv*) with the woody tissue on the inner side. A line bisecting the two bundles of the stem forms an angle of about 45° with the median line, while the bundle of the petiole is symmetrically arranged, *i. e.*, it is bisected by the median line. The petioles of the other two kinds of leaves are, in this respect, exactly like the filiform ones. It is instructive to observe how the double bundle of the stem separates into two branches on approaching the node, one of them leading to the inflorescence and apex, the other continuing its course into the leaf.

Otherwise the stem and the petiole do not present any material differences. Both have two additional, much more reduced fibro-vascular bundles near the circumference, on opposite sides from the central one, with which they anastomize, at certain intervals, by means of obliquely ascending, tender branches. The bulk of the stems and petioles consists of large parenchyma cells which have very large intercellular channels between them, in the manner of so many aquatic plants. We find, stretched obliquely across these air-canals, some peculiar diaphragms formed of rather flat cells and pierced with numerous triangular intercellular spaces. Such diaphragms are considered as a mechanical contrivance to stiffen the walls of the air-canals in which they grow. Their occurrence in *Limnanthemum* is particularly interesting, because together with them are found those star-shaped cells so frequently observed in *Nuphar* and *Nymphæa;* for it has heretofore been thought that plants having these stellate "interior hairs" are not provided with any diaphragms.* The manner in which the former grow, leaves, with me, no doubt as to their office.

The walls of the intercellular channels (Fig. 8, *p*) are formed of single layers of cells among which the star-shaped ones are conspicuous by their great number, their form and their very thick, lignified walls. There are, however, not any of the granular crystals of calcium oxalate imbedded in the substance of the wall and projecting from it as with *Nuphar* and *Nymphæa.*† The several arms into which such a cell branches project into the intercellular passages (Figs. 8 and 9), and spread in front of the partitions (Fig. 10) into which the main body of the cell is inserted. Considering the length

*G. Haberlandt, Physiologische Pflanzenanatomie (1884), p. 300.

† G. Haberlandt, *l. c.*; E. Strasburger, Das botanische Practicum, p. 171. In our *Nymphæa odorata*, Ait., however, I have found very many "stellate hairs" with quite smooth walls, without the crystals mentioned in the text. They occur together with such cells as those of *N. alba* described by Strasburger, *l. c.*

of these branches, as well as the hardness and rigidity of these peculiar cells, together with their great number, we must assume that they serve as a mechanical contrivance to prevent the collapse of the wide air-passages which, without them, might take place on a sudden or gradual change in the radial pressure exerted on the plant by the water and the atmosphere.

This summer I planted a cluster of the spur-like rootlets mentioned above in some sand contained in a shallow dish and covered with a few inches of water. The bud above the rootlets soon sent up some of the submersed leaves, which, in shape and size, exactly resembled the ones collected from the actual habitat of the plant. But on closely examining their petioles I was surprised to find that they did not contain a single stellate cell! I do not venture to consider this single observation as a proof of the correctness of the above theory, but it certainly does not contradict it, and invites closer investigation.

Hoboken, December 1884.

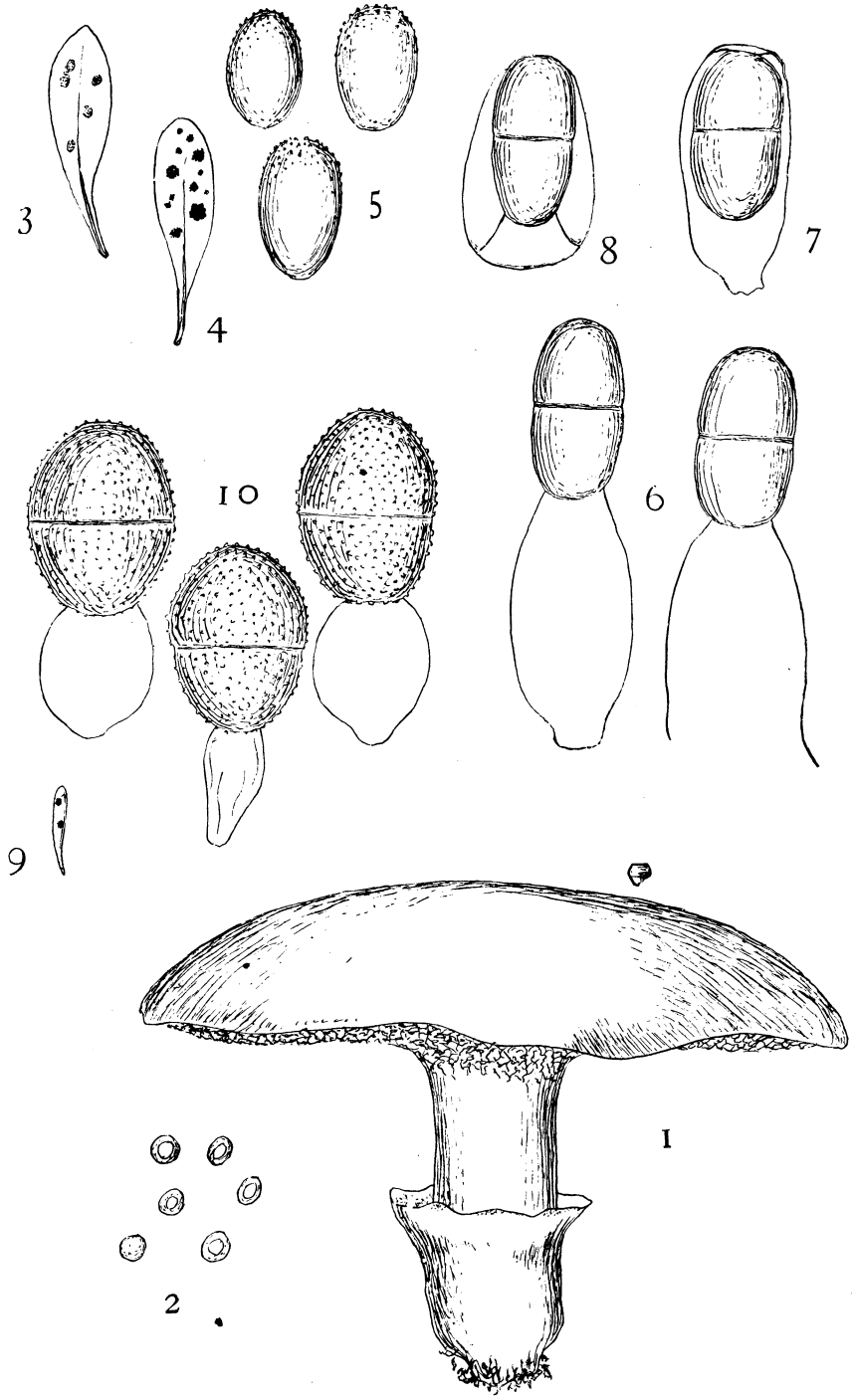
EXPLANATION OF PLATE XLVIII.—Fig. 1. Cross-section of filiform stem. *e*, epidermis; *se*, sub-epidermal layer of parenchyma consisting of two or three rows of cells with few and small interstices; *i*, intercellular air-canals; *ic*, air-canal magnified in Fig. 8; *p*, partitions between air-canals; *cb*, central fibro-vascular bundle; *lb*, lateral bundles; x 36. Fig. 2. The central fibro-vascular bundle of Fig. 1, x 370. *en*, endodermis; *v*, ducts (annular and spiral); *sv*, sieve tissue. Fig. 3. Central fibro-vascular bundle of filiform petiole. Letters as in Fig. 2; x 370. Fig. 4. A few of the numerous stems, leaves, etc., of a full grown plant to illustrate its habit. The filiform petioles and stems of the original were about .5$^{m.}$ long. *bt*, bottom of lake; *sl*, submersed leaves, *sc*, scales; *pt*, filiform petioles; *st*, filiform stems; *sp*, spur-like roots; *sf*, surface of water. Fig. 5. Bases of leaf-organs. Letters as in Fig. 4. Fig. 6. Young plant that has grown from the spur-like roots, *sp*. Fig. 7. Cross-section of one of the spur-like rootlets (Fig. 4). *e*, epidermis; *pc*, parenchyma cells; *en*, endodermis; *v*, ducts; *sv*, sieve-tissue; x 36. Fig. 8. Intercellular canal, *ic*, Fig. 1, x 36. *sh*, stellate "hairs"; other letters as in Fig. 1. Fig. 9. Longitudinal section through air-canal and stellate "hair"; x 370. Fig. 10. Longitudinal section through air-canal, giving front-view of stellate "hair", the invisible half of which extends behind the partition into the contiguous air-passage; x 370.

All the powers given refer to the original figures as drawn with the camera; in the plate they appear reduced to one-half their size.

On the Mechanism of Anthesis in the Ericaceæ

By H. H. RUSBY.

As to the anthers, a strong distinction exists between the Pyrolineæ and the remainder of the Ericaceæ, in that the pores are basal in the former, apical in the latter. But this characteristic is not so readily made out as would at first appear. On examining a mature flower in any sub-order, the pores are found uppermost, and the only apparent indication of inversion in the Pyrolineæ is the common extrorseness of the pores, the anther itself being introrse. But even this distinction vanishes, nearly, in *Clethra*, where the poriferous horns are twisted so as to face laterally, and quite so in *Chimaphila*, where the horns are very short, and the openings look obliquely upward and inward. When we turn to the bud of *Clethra*, we find the filament doubled upon itself, so that the poriferous horns are pointing downward. In very young buds this reduplication of the filament is not apparent, the fold be-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